

REMARKS

Claims 1-16 are all the claims pending in the application. Independent claims 1 and 14 have been amended.

Claim Rejections - 35 U.S.C. § 102

Claims 1-11 and 14 are rejected under 35 U.S.C. § 102(e) as being anticipated by Liebowitz et al (5,812,545). This rejection is traversed.

The Present Invention

The present invention concerns the provision of internet protocol (IP) multicast services on mesh satellite networks, of the type illustrated in Fig. 1. As explained at page 3, line 9 of the application, the most straight forward technique for supporting multicast IP routing in a mesh satellite network is to incorporate such capabilities into each terminal. Each terminal having a router must periodically communicate with all the terminal/routers in the mesh, thereby using satellite bandwidth, as well as significant CPU and memory resources, including the provision of prune-state tables.

In order to provide a bandwidth-efficient technique for routing multicast IP traffic over meshed satellite networks, according to the present invention, the multicast routing protocols are run in a centralized route server. In a baseline implementation illustrated in Fig. 1, external hosts/subnets connect to satellite TDMA terminals through multicast enabled routers. External routers establish multicast routing sessions only with a route-server, and not with the other terminals. Thus, multicast routing packets originated by an external router attached to a terminal will be conveyed transparently to the common route server and used to create multicast group table information at the route server. This information is provided by the single route server to the terminals so that multicast traffic can be directly transmitted from the ingress terminal to all the terminals in a group, without having to be relayed through the route server. As illustrated in Fig. 1, the route server 40 is disposed at a master terminal 32 and is connected to a network control center 30, which communicates with the satellite 12 via the master terminal. Other terminals 16, 34, 18, 36 at separate ISPs are connected to various routers (52, 54, 58) for access to external equipment.

As explained at page 5, in addition to a normal network configuration, a route-server (RS) 40, which can be connected by a further router 50 via a WAN link to the internet 68, may be on the same LAN as a network controller 30 and a master terminal 32. In the relevant protocol, as illustrated in Fig. 2, a master routing table is established in the RS 40 by communication among the RS and other routers 52, 54, 56, 58. Unlike the prior art arrangement of Fig. 3, the invention permits a reduction in the number of slots required for routing information updates, as illustrated in Fig. 4. This reduction occurs because the routing information is exchanged only between each router and the RS 40, and not among all routers.

This fundamental feature of the present invention is recited in the claims, particularly claim 1 where there is a system defined with a plurality of terminals for providing IP multicast services as well as (1) a route server for establishing and maintaining routing information for a plurality of routers and (2) a controller operative to allocate broadcast burst to the terminals based on requests from the terminals via said router server. The requirement for the allocation of broadcast bursts based on requests from terminals "via said route server" is significant because it emphasizes the distinctive feature of the invention that information for such transmissions is exchanged only between external routers and the route server, and not among the external routers directly, as disclosed at page 7 of the present application. Similarly, for method claim 14, the fundamental features are recited of establishing and maintaining routing information for a plurality of routers, allocating TDMA slots to the terminals based on requests from the terminals via said router server and broadcasting the IP multicast services over the slot according to the routing information in the route server.

Prior Art

In the Examiner's analysis supporting his rejection of claims 1 and 14, the Examiner looks to Liebowitz, particularly Fig. 1, for an illustration of a GT 12 acting as a "route server", as detailed in Fig. 3, and a PCD in Fig. 3 acting as the claimed "controller". The Examiner identifies the management terminal MT as the structure for determining how to allocate bandwidth among a plurality of terminals, as discussed at col. 6, lines 1-12. Liebowitz does teach a TDMA satellite network and the assignment of one slot in a TDMA frame to one of a plurality of terminals. Further, Liebowitz does teach broadcasting IP multicast services over at least one slot.

However, Applicants submit that (1) Liebowitz is primarily concerning with efficient allocation of bandwidth resources among a plurality of terminals in a satellite-based mesh network and (2) is not concerned with the distribution of transmitted information to or from client equipment via routers that are external to the terminals. In short, Liebowitz does not teach a route server that contains routing information for a plurality of routers, nor a controller that allocates broadcast bursts on request via the route server, as disclosed and claimed.

Claim 1

In particular, with reference to Fig. 1 of Liebowitz, the system comprises a plurality of terminals 12, one of which is a manager terminal (MT) and the other is a gateway terminal (GT), which serves as a gateway to a network management center 13. The primary focus of the invention, as explained at col. 2, line 30 is to provide a satellite communications system that provide full mesh connectivity among a number of earth terminals via satellite link. Each terminal has a programmable computing device (PCD) which processes data in the form of frames of several known formats and can prioritize data into bursts using a fragmentation protocol. The bursts are organized in at least one of a plurality of slots constituting a TDMA frame in accordance with the burst plan. The slots may be fixed duration or variable duration, in the latter case, each terminal having access to a guaranteed number of slots in the remaining slots being allocated dynamically to increase or decrease burst transmission rates of the terminals as needed.

Each terminal has a common structure, which includes a fragment assembler/disassembler (FAD) 66, which ensures that appropriate bandwidth allocations are made for that terminal. The allocation of bandwidth among all the terminals, based on their collective bandwidth request, is determined by a terminal operating as the MT. Each terminal will transmit TDMA bursts to the satellite 14, where they are rebroadcast on a downlink to all other terminals 12 tuned to an assigned carrier.

The data frames directed towards a terminal by a local user access device 43 for transmission would be fragmented for transmission efficiency, multiplexed according to a priority scheme and stored in burst buffers for burst transmission at a prescribed time, as disclosed at col. 5, line 58 - col. 6, line 62. As to the terminal acting as the gateway (GT), the

patent merely teaches that the GT acts as a gateway to the MMC 13, particularly for statistics transmitted by the MMC 78 in each terminal based on error messages and traffic reports. (col. 8, lines 14-45). There is no other reference to the GT as performing any function relevant to a route server or specifically, serving as a connection to other external routers or as a central resource for all routing information. This structure is merely a gateway.

The disclosure of the use of a burst plan and the role of the MT in broadcasting the burst plan to other terminals each frame is disclosed at col. 11, line 19 - col. 13, line 51. The assignment of burst within the burst plan according to permanent throughput, guaranteed throughput and dynamic throughput is discussed in the same section. However, none of this discussion relates to the implementation of a central router or route server for all routers in the network. Indeed, the concern with efficiency in the routing function is nowhere discussed in Liebowitz et al. Only the present invention discusses this problem and provides a solution that improves upon the conventional approach.

Claim 14

Claim 14 is directed to a method and includes the limitation that there is a route server, thereby distinguishing over Liebowitz for the reasons already given. Moreover, claim 14 requires at least one slot of the TDMA frame to be used for broadcasting IP multicast services. With regard to Liebowitz, as disclosed at col. 9, line 19, a TDMA frame 96 is shown in Fig. 6 and contains a plurality of individual slots 99 that remain constant during network operation but can be changed by network management action, as explained at col. 9. As explained at lines 33, the frame has a small fixed assignment subframe 100 and a larger dynamic assignment frame 102. In a fixed assignment frame 100, the slots are dedicated to respective terminals 12, and the collection of frames constitute a superframe 104. A burst in each fixed assignment subframe 100 may be used to transmit a burst plan from the MT and other terminals may be assigned at least one burst per superframe in which to send a bandwidth request and/or a payload with data. As explained a col. 10, lines 3-11, the superframe constitutes 500 slots with 90 dynamically assignable slots per frame. The remainder of the disclosure with regard to Fig. 7, representing the content of a burst, at col. 10, line 12 - col. 17, line 33, discusses the content of the frames and the bursts, but do not indicate use of a single slot for transmission of broadcast information. The teaching at col. 18, line 7 simply mentions that the data stream from each party is seen by

each other party in the system. However, there is no dedication of a portion of the frame to broadcast transmission as claimed. While broadcast and multicast transmission capability is mentioned at col. 2, line 26, the claimed features of the invention involving the assignment of a particular slot for such purpose is not disclosed. The term "broadcast" as used in Liebowitz appears to mean that the TDMA bursts transmitted to a satellite and returned on a down link to all other terminals tuned to a carrier can be monitored by any station receiving the carrier and the bursts transmitted onto the carrier, as illustrated in Fig. 5. In fact, as disclosed at col. 7, line 31, the TDMA overhead bytes in the header of a burst comprise bits specifying a terminal identifier which unique identifies a terminal 12 within the system. While the MT broadcasts a burst plan to all terminals 12 once per frame 96, as explained at col. 11, lines 30, this is not the type of transmission that is set forth in the claim, and there is no basis for asserting that a dedicated slot for burst transmissions is used for this purpose.

Even though Applicants believe that the original claims 1 and 14 distinguish from Liebowitz for the reasons given above, in order to emphasize that the route server is operative to serve plural routers and to maintain routing information for those routers, claims 1 and 14 have been amended to expressly state this function. This function is not disclosed in Liebowitz. Moreover, claim 14 has also been amended to state that the common route server is coupled to a master terminal. On the basis of the foregoing analysis and the amendment to claims 1 and 14, all of claims 1-11 and 14 would be patentable over Liebowitz as it does not anticipate the claimed features of the invention.

Claim Rejections - 35 U.S.C. § 103

Claims 12 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Liebowitz. This rejection is traversed.

The Examiner comments that the subject matter of these claims, namely multicast routing using a DVMRP or VIM-SM protocol is obvious in view of the teachings of Liebowitz, even though Liebowitz fails to teach these protocols specifically. As already noted, Liebowitz does not anticipate the present invention. Moreover, the use of a central route server that is interconnected to routers throughout the network and contains routing information for a plurality of routers, in combination with a controller operative to allocate broadcast bursts based on

requests from terminals via said route server is not seen in the prior art. Thus, this rejection should be overcome.

Claim 15 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Liebowitz et al in view of Francis et al (5,331,637). This rejection is traversed.

The Examiner asserts that Liebowitz teaches a terminal transmitting to a satellite and for transmission to a route server but admits that Liebowitz fails to expressly teach the transmission of a prune message. The Examiner looks to Francis for a teaching of a DVMRP tree construction where each router receives a multicast packet and sends a copy of the packet to each of the routers attached thereto. The Examiner looks to the teachings in col. 4, lines 1-31 for a teaching of prune message transmission in order to determine the shortest path to a destination.

As already noted, Liebowitz completely fails to discuss or disclose the functions provided by a common route server, as claimed. Francis does not remedy this deficiency. In particular, Francis is concerned with a generic internet communications network 80, as shown in Fig. 1, having several backbone networks, each connecting to a "stub" network having one or more interconnected sub-networks. The disclosure does not concern any internet communications network having a satellite-based component, particularly one that operates with a time division multiple access (TDMA) protocol. The goal in Francis is to improve upon the conventional multicast transmission techniques used for packet delivery, particularly the distance-vector multicast routing protocol (DVMRP) and the link-state multicast routing protocol (LSMRP).

The DVMRP multicast tree construction method uses a modified reverse path forwarding algorithm to construct shortest path, sender-based multicast trees. In an internet system having plural routers and, in setting up a tree, the multicast packet is transmitted by each router, which transmits the packet in turn to other routers attached thereto. Routers which receive these packets may indicate that they are not on a path to a destination node in a multicast group by transmitting a packet containing a special "prune" message to the router from which the multicast packet was received. For each source node-multicast group pair, each router keeps track of the routers from which prune message have been received. This list is used to determine at each router those other routers that should receive subsequently transmitted multicast packets.

In the LSMRP, each router maintains information regarding each link or each direct connection to another node, as well as a list of each multicast group having one or more member nodes on the link. Each router disseminates these lists for each multicast group to the other routers of the internet. In both the DVMRP and LSMRP-based systems, vast amounts of storage space must be utilized, thereby creating a disadvantage, as disclosed at col. 4, line 1 - col. 5, line 28. Clearly, none of the teachings for the DVMRP or LSMRP approaches are relevant to the claimed invention since they rely upon multiple routers that store system-wide information, each router thereby contributing to the inefficiency of the system by maintaining membership information over the entire network. There is no central route server, using a master table for all routers, that establishes and maintains routing information for a plurality of local routers.

The improvement in Francis is intended to provide greater efficiencies by using a central node based multicast tree construction. According to one embodiment, each multicast group is initially assigned a core node which serves as the route of a corresponding multicast tree. The core node is assigned two addresses, one for unicast routing and the other for multicast routing. Nodes may join in the multicast group, thereby forming branches. Where a node wishes to join a multicast group, it must write an address of the node from which a packet was received in an entry of a forwarding table (unicast forwarding table) maintained at the receiving node. The entry is indexed by the multicast address of the core node contained in the packet. Thus, by using the core node multicast address, entries may be retrieved indicating the next node on a path to the core node. Where a source node writes a multicast address of the core node corresponding to a multicast group in a data packet, the transmitted packet when received by a node on the multicast tree retrieves the forwarding table entry indexed by the destination address of the packet, i.e., indexed by the multicast address of the core node. The retrieved entry indicates one or more other nodes on the tree to which copies of the packet are to be transmitted. As summarized in the patent at cols. 5-6,

"in short, a core based multicast routing method is disclosed in which one or more core nodes are designated as a reference for constructing one multicast tree for each multicast group. The multicast routing method according to the invention conserves storage space and processing resources at each node."

Nothing in Francis teaches a common route server or would lead to the implementation of a common route server in Liebowitz et al, since no common route server is disclosed. Francis merely considers the use of a core node, whose address may be used for convenience establishment of a multicast tree. However, a core node does not serve as or contain a route server.

Thus, even though Liebowitz concerns a TDMA satellite system having the capability of transmitting information in dynamically assigned slots, the deficiency in Liebowitz with regard to the absence of a route server operative to serve as a central exchange for routing information from plural remote routers and to assign slots in a TDMA frame to the terminals based on requests from terminals and to update the common route server is not remedied by Francis. Francis does not concern a satellite system nor a TDMA network and does not have a route server that operates in the manner claimed.

Notably, the router 42 in Fig. 3 of Liebowitz is nothing more than a "local user access device" as discussed at cols. 4-6 and are grouped together with other such devices, including telephones, video conference equipment, computers and networks that may connect to a satellite terminal 12. Notably, the "pruning" technology discussed in Francis relates to the inefficient DVMRP architecture, which Francis characterizes as highly inefficient and wasteful of memory space. Nowhere is the pruning technique discussed with regard to the use of a core node in connection with the preferred embodiment of the invention in Francis. Moreover, as already discussed, this core node approach does not contemplate the use of a route server, as claimed.

On the basis of the foregoing, neither Liebowitz nor Francis alone or taken together would render the claimed invention unpatentable.

Claim 16 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Liebowitz et al in view of Virgile (5,898,686). This rejection is traversed.

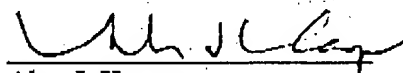
First, with regard to the parent claim 14, as already noted, Liebowitz does not teach a common route server and cannot teach the step of establishing and maintaining routing information in such device, nor the communication of plural local routers with a common route server so that broadcast bursts may be generated based on the routing information in the route server.

The Virgile patent is concerned with a system and method for routing multicast packets in a subnetwork in order to conserve bandwidth. The architecture of the Virgile system is illustrated in Fig. 3, which shows a subnetwork including a bridge. The fundamental assumption of the Examiner is that Liebowitz discloses everything set forth in the claim except, as admitted by the Examiner, teaching the sending of a "joined message". The Examiner asserts that Virgile teaches in Fig. 5, step S11, a part of a process for enabling a terminal to join a host group, so that entries to a common table may be updated. However, in the absence of a common route server, in either the Liebowitz or Virgile patent, or the communication of a plurality of routers with a common route server, the claimed subject matter cannot be rendered unpatentable.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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APPENDIX**VERSION WITH MARKINGS TO SHOW CHANGES MADE****IN THE CLAIMS:**

The claims are amended as follows:

1. (Amended) A system for offering Internet Protocol (IP) multicast services in mesh TDMA satellite networks, said system comprising:

a plurality of terminals for providing said IP multicast services, each terminal being connected to at least one local router;

a route server in communication with a plurality of said local routers for establishing and maintaining routing information for said plurality of local routers; and

a controller operative to allocate broadcast bursts to said terminals based on requests from said terminals via said route server.

14. (Amended) A method for offering Internet Protocol (IP) multicast services in a mesh TDMA satellite network having a plurality of terminals connected to local routers, and a master terminal, said method comprising:

establishing and maintaining routing information for said plurality of local routers, in a common route server coupled to said master terminal, by exchanging information between each of said local routers and said common route server;

responding to a request for multicast services by assigning at least one slot in a TDMA frame to one of a plurality of terminals and updating said routing information in said common route server based on said assignment;

broadcasting said IP multicast services over said at least one slot according to said routing information in said common route server.